THE USE OF THE MICROSCOPE IN ELEMENTARY BIOLOGY

In recent years there has been considerable criticism of courses in Biology, arranged for high school students, which commence with the cell and the simpler organisms and pass upward along the ascending scale of animals or plants.

The nub of this criticism has included two main points: (1) the time honored doctrine that teaching should pass from the known to the unknown, rather than the reverse; and (2) the microscope is itself such a difficult and complex instrument, and the interpretation of its story so uncertain and puzzling to youth, that it ought to come, if at all, much later in the course.

There is of course something in each of these contentions, and as scientists and citizens, whether we are teachers or not, we are all interested in the question. Many good teachers have wholly given up the strong advantage that comes from following the evolutionary order, and begin with the more complex but better known organisms; and some cut out the use of the microscope almost altogether.

The writer is glad, however, to be able to offer here, out of his own experience, at least one suggestion, which may serve to moderate this attack on the microscope as unpedagogical and undesirable for use as a high school implement.

In a series of classes of high school age, a number of records have been made, unknown to the pupils, of tests as to the attitude of the pupils toward laboratory work that involves the use of the microscope in comparison with that which does not. It is unnecessary here to give a detailed statement of the points on which the record was made. Various things that indicate to the teacher an interest on the part of the pupil were noted:—degree of concentration; the sustaining of effort completely to the end of the period; facial and bodily attitudes indicative of attention; the voluntary expressions of the pupils, etc.

The following conclusions are based on these records:

1. The classes show every evidence of being as much interested in the study of the *microscope itself, as an instrument,* through the whole of a two-hour period given to its examination and to the discussion of its parts and their uses, as in any thing else in the whole course in Biology. The microscope, as a man-made instru-

ment of precision, is well worth the student's time; there is no place more appropriate for its study than in a course in Biology, to which it has made its most notable contributions; and the student is interested in it. These facts make a good pedagogical combination.

2. All the special technic which the high school student *must* have at the outset can be mastered in one two-hour exercise; and there need not be a single dull moment in that time. The utmost skill that the secondary pupil will need, in order to have the microscope a very valuable aid thru all his course, can be picked up day by day incidental to the actual use of it.

3. In my own experience, 95% of these student show by my tests, and avow for themselves, a more intense interest in the aspects of biology calling for the use of the microscope than in the non-microscopic work of the course. The microscopic work compares favorably with the very best field-work that I have ever been able to organize, in its attraction for even the elementary students.

It is not the desire of the writer to conclude from these observations that the microscopic work should bulk large in a beginning course; but rather to insist that the greater interest of it does at least mitigate the unpedagogic leap into the unknown territory of the cell and unicellular organisms. If there is any thing in the doctrine of interest in education, this increased interest may even justify the teacher in beginning thus low down, merely in order to get the inspiration which this new point of view may yield. This may enable the pupil to approach the organisms, *which he thinks he knows*, in a more open spirit; and this is a result quite worth seeking.

Indeed, we have found in our laboratory that the privilege of applying the microscope to some part of the larger animals, either in extemporized preparations or in permanent mounts, is often of great pedagogical value in holding the pupil's interest to the gross studies. The microscopic "demonstrations" often used for general purposes are much more meaningful to students who have had a first-hand experience with the instrument in their own work.

For these reasons the writer feels that there is need of a reaction in favor of a wiser, and probably a more extended, use of this most splendid instrument in even elementary courses. Most of our pupils do not get beyond the high school; and it is not fair that the recent vogue of the utilitarian and out-door phases of biology

should rob the coming generation of a first-hand chance to appreciate a little of the actual world of the minute, and of the marvelous instrument which makes its study possible.

Mr. Edward Pennock of Philadelphia is featuring the newly designed Pietzsch Microtomes for general laboratory use. It is claimed that these instruments are of very perfect workmanship and do exceptionally accurate work.

As is well recognized, the glass covers used so much by microscopists vary greatly in thickness even tho sold under standard numbers. The following table gives the actual result of measurement of the contents of two ½-ounce boxes (taken at random) graded as No. 1, of a certain make which apparently are largely imported and sold in this country. The thicknesses given are in thousandths of an inch:

½-OUNCE, 92 COVER-GLASSES

(Sold as No. 1, which should not exceed limits of 5 to 7 thousandths)

1 is .003 in.	13 are .005 in.	4 are .007 in.
5 are .0035 in.	13 are .0055 in.	5 are .0075 in.
9 are .004 in.	8 are .006 in.	1 is .008 in.
22 are .0045 in.	10 are .0065 in.	1 is .0085 in.

½-OUNCE, 82 COVER-GLASSES

(Sold as No. 1, which should not exceed limits of 5 to 7 thousandths)

1 is .003 in.	11 are .0055 in.	6 are .0075 in.
3 are .0035 in.	5 are .006 in.	4 are .008 in.
7 are .004 in.	10 are .0065 in.	3 are .0085 in.
15 are .0045 in.	7 are .007 in.	1 is .0095 in.
9 are .005 in.		

In each case, it will be seen, 48 PER CENT measure outside the limits of No. 1.

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